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Perception of hearing loss among call center workers in Barranquilla (Northern Colombia).

Percepción de pérdida auditiva en trabajadores de call center en Barranquilla (Norte de Colombia)

Diana Matilde Otero Vargas, Alexis Cortina Hernández, Karina Paola Buelvas Almanza & Carlos Alberto Severiche Sierra.

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CORREO:

- otero@uniminuto.edu.co
- alexis.cortina@uniminuto.edu.co
- karina.buelvas@usbctg.edu.co
- carlos.severiche@uniminuto.edu.co

ORCID:

- https://orcid.org/0000-0003-0668-5664
- https://orcid.org/0009-0006-4483-3751
- https://orcid.org/0009-0001-3522-0316
- https://orcid.org/0000-0001-7190-4849

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Abstract

The perception of hearing loss and listening effort was investigated among call center agents in Barranquilla (2025), a high-demand, noisy environment. This was a cross-sectional observational study with convenience sampling. Fifty-five valid questionnaires from workers with ≥3 months of seniority and headphone use were analyzed. The instrument, adapted from the HHIA, QSHL, and a THI module, included 18 items (No/Sometimes/Yes) recoded 0–2 for a score of 0–36 (α=0.71). Frequencies and descriptive statistics were estimated. The mean score was 16.04 (SD=9.27); 85.5% had ≥1 affirmative response, and 20.0% reported tinnitus at the end of the shift. The highest proportions of "Yes" responses were observed for requests for repetitions, difficulty understanding with floor noise, anxiety under high workloads, and concern about performance and possible hearing impairment. This profile suggests speech intelligibility deficits in noise and high cognitive load with preserved clinical thresholds, consistent with listening effort frameworks and subclinical pathophysiology.

Palabras clave: Noise Pollution; Hearing Loss; Tinnitus; Occupational Health; Work Environment.

Resumen

Se investigó la percepción de pérdida auditiva y el esfuerzo de escucha en agentes de call center de Barranquilla (2025), un entorno de alta demanda comunicativa y ruido. Estudio observacional transversal con muestreo por conveniencia; se analizaron 55 cuestionarios válidos de trabajadores con ≥3 meses de antigüedad y uso de diademas. El instrumento, adaptado de HHIA, QSHL y un módulo del THI, incluyó 18 ítems No/A veces/Sí recodificados 0–2 para un puntaje 0–36 (α=0,71). Se estimaron frecuencias y estadísticos descriptivos. La media del puntaje fue 16,04 (DE=9,27); 85,5 % presentó ≥1 respuesta afirmativa y 20,0 % refirió tinnitus al final de jornada. Las mayores proporciones de "Sí" se observaron en pedir repeticiones, dificultad para entender con ruido de piso, ansiedad en altas cargas y preocupación por el desempeño y un posible empeoramiento auditivo. Este perfil sugiere déficit de inteligibilidad del habla en ruido y elevada carga cognitiva con umbrales clínicos conservados, coherente con marcos de esfuerzo de escucha y fisiopatología subclínica.

Keywords: Contaminación por Ruido; Pérdida Auditiva; Tinnitus; Salud Laboral; Ambiente de Trabajo.

Introduction

Contact center operations require continuous communication, speech understanding in varying acoustic conditions, and prolonged use of headsets. These characteristics increase listening effort, especially in the presence of background noise, low-intensity voices or diverse accents, and fluctuating telephone signal levels. Recent literature describes that, in scenarios with signal degradation, speech intelligibility depends on greater attentional investment and cognitive resources, with consequences for fatigue and performance (Pichora-Fuller et al., 2016; Peelle, 2018; Francis & Love, 2020).

In occupational health, the effects of noise encompass auditory and non-auditory dimensions that impact well-being and productivity, even when average exposures meet regulatory thresholds (World Health Organization [WHO], 2018; Munzel et al., 2018). In particular, workdays with high call density and floor noise can increase repetitions, stress, and auditory discomfort, potentially affecting quality metrics (Masterson et al., 2016; Le Prell & Spankovich, 2018).

In parallel, the auditory neuroscience literature has proposed subclinical mechanisms such as noise-induced cochlear synaptopathy that are associated with difficulties understanding speech in noise despite “normal” pitch thresholds (Liberman & Kujawa, 2016; Bramhall et al., 2019). In young people with preserved audiograms, physiological and behavioral markers have shown complex relationships between exposure history, early neural response, and performance on speech-in-noise tasks (Prendergast et al., 2017; Guest et al., 2018), which is relevant for contexts with intensive headband use.

The Framework for Understanding Effortful Listening (FUEL) integrates auditory and cognitive findings and explains how signal degradation, noise, and task complexity increase mental workload and perceived fatigue (Pichora-Fuller et al., 2016). Recent studies have delved into the valid measurement of listening effort and its relationship with work and well-being outcomes, providing instruments and interpretation criteria applicable to workplace monitoring (Alhanbali et al., 2017; Peelle, 2018; Francis & Love, 2020).

Self-reported hearing loss perception complements traditional screening, as it captures functional domains such as speech understanding in noise, post-shift tinnitus, need to increase volume, and fatigue, which are not always reflected in pitch thresholds (Smits et al., 2016; Bhatt et al., 2016; Tikka et al., 2017). This approach is useful for prioritizing engineering interventions, work organization, and on-the-job training (WHO, 2018; Tikka et al., 2017).

In Barranquilla, a BPO services and employment hub in the Colombian Caribbean region, the local characterization of the perception of hearing loss among call center workers is strategic for guiding contextualized preventive actions. This study describes this perception and its associated manifestations among operational staff of call centers in the city, providing evidence applicable to hearing risk management programs and decisions regarding noise control, equipment, and health surveillance (Masterson et al., 2016; Liberman & Kujawa, 2016; WHO, 2018).

Methodology

An observational, analytical, and cross-sectional study was conducted among call center workers in Barranquilla, Colombia, during 2025, reported according to STROBE (von Elm et al., 2007). The target population was service, sales, or support operational agents with ≥3 months of seniority and habitual headset use. Individuals ≥18 years of age with electronic informed consent and questionnaires with ≥90% completeness were included; cases with acute disabling otological conditions in the previous two weeks or inability to respond were excluded. Non-probability convenience sampling was performed, scheduled by shifts and availability, and the analytical sample was reduced to 55 valid questionnaires after quality control (von Elm et al., 2007).

The instrument was designed using the HHIA for perceived hearing handicap (Newman et al., 1990), the QSHL for self-report functional screening (Nondahl et al., 1998), and an optional brief module of the THI for tinnitus/hyperacusis symptoms (Newman et al., 1996) as frameworks, and adapted linguistically and contextually to the call center environment with expert review by audiology and SST experts and pre-tested cognitive assessment. An abbreviated 18-item No/Sometimes/Yes index, recoded as 0/1/2 and summed to a total score of 0–36, was used for the main analysis. Internal consistency was acceptable (Cronbach's α=0.71), supporting its use as a screening and perceived severity measure (Newman et al., 1990; Nondahl et al., 1998). The choice of domains and items was supported by evidence on speech intelligibility in noise, listening effort, and auditory and non-auditory effects of noise in work contexts with high communicative demand (Basner et al., 2014; Pichora-Fuller et al., 2016; Peelle, 2018; Francis & Love, 2020; WHO, 2018).

Data collection was conducted online using Google Forms, anonymously and voluntarily, with a four-week reference period. Quality controls were implemented (key mandatory fields, skip logic, duplicate detection), and relevant covariates were captured: sex, age, seniority, shift type, daily hours of headphone use, headband type (monoural/binaural/noise-cancelling), history of surveillance audiometry (pre-admission and periodic), and hearing hygiene training, in accordance with guidelines and reviews on environmental and occupational noise exposure (Basner et al., 2014; WHO, 2018).

The analysis included item descriptors (frequencies and percentages for No/Sometimes/Yes), proportion of participants with ≥1 affirmative response, and total score statistics (mean, SD, median, range, and IQR). Internal consistency (Cronbach's α) was estimated for the 18-item index. Scores and proportions were compared exploratory across exposure levels (e.g., hours/day with headphones, headset type, training) using χ^2 for proportions and Student's t/ANOVA or nonparametric tests as appropriate. Adjusted associations were optionally modeled with linear regression for the total score and robust Poisson or ordinal logistic models for severity categories, adjusting for age, sex, tenure, daily exposure, headset type, and training (von Elm et al., 2007). The interpretation was anchored in conceptual frameworks of listening effort and pathophysiological evidence that recognizes the possibility of subclinical auditory dysfunction (e.g., cochlear synaptopathy) even with normal tonal thresholds, especially in the face of degraded signals and background noise (Liberman & Kujawa, 2017; Pichora-Fuller et al., 2016; Peelle, 2018).

As operational criteria for occupational health, audiological referral was prioritized when multiple affirmative responses were observed in domains of noise intelligibility, presence of post-workday tinnitus, or high exposure (≥4–6 hours/day with headphones). This was achieved by articulating engineering and organizational control actions, hearing hygiene education, and periodic monitoring, in line with guidelines and evidence on interventions to prevent noise-induced hearing loss (WHO, 2018; Tikka et al., 2017). The study was conducted in accordance with the Declaration of Helsinki and applicable Colombian regulations; participation was voluntary, with electronic informed consent, without identifiable data, and with a guarantee of confidentiality. Those who met referral criteria were offered recommendations for audiological assessment and preventive measures (von Elm et al., 2007; WHO, 2018).

Results and discussion

Fifty-five valid questionnaires from call center staff were analyzed. The instrument consisted of 18 Likert-type items (No/Sometimes/Yes) on manifestations of hearing difficulty, emotional reactions, and functional restrictions during work. For the analysis, No = 0, Sometimes = 1, and Yes = 2 were recoded, and a total score was calculated per participant (theoretical range 0–36). Internal consistency was acceptable (Cronbach's α = 0.71).

The total score had a mean of 16.04, standard deviation of 9.27, median of 16, range of 0–36, and IQR of 7.5–24.0. The proportion of participants with at least one “Yes” item was 85.5% (47/55). The item that inquires about ringing/whistling after the shift (perceived tinnitus) obtained a “Yes” score of 20.0% (11/55).

The highest proportions of “Yes” responses were observed for speech intelligibility difficulties and concern about performance and potential hearing deterioration (Table 1).

Table 1.

Items with the highest proportion of “Yes” responses (n=55).

Item	Without)	Yeah (%)
5. Do you feel uncomfortable when you don't understand a customer and have to ask them to repeat themselves?	35	63.6
4. Are you concerned that your hearing difficulties will affect your performance or quality metrics?	33	60.0
14. Do you have difficulty understanding the client when there is ambient noise in the apartment?	28	50.9
2. Do you feel anxious or tense about your hearing during days with a high call volume?	26	47.3
10 Are you worried that your hearing might worsen if you continue in this position?	25	46.3

Source: Own elaboration

Figure 1.

Distribution of the total score (0–36)

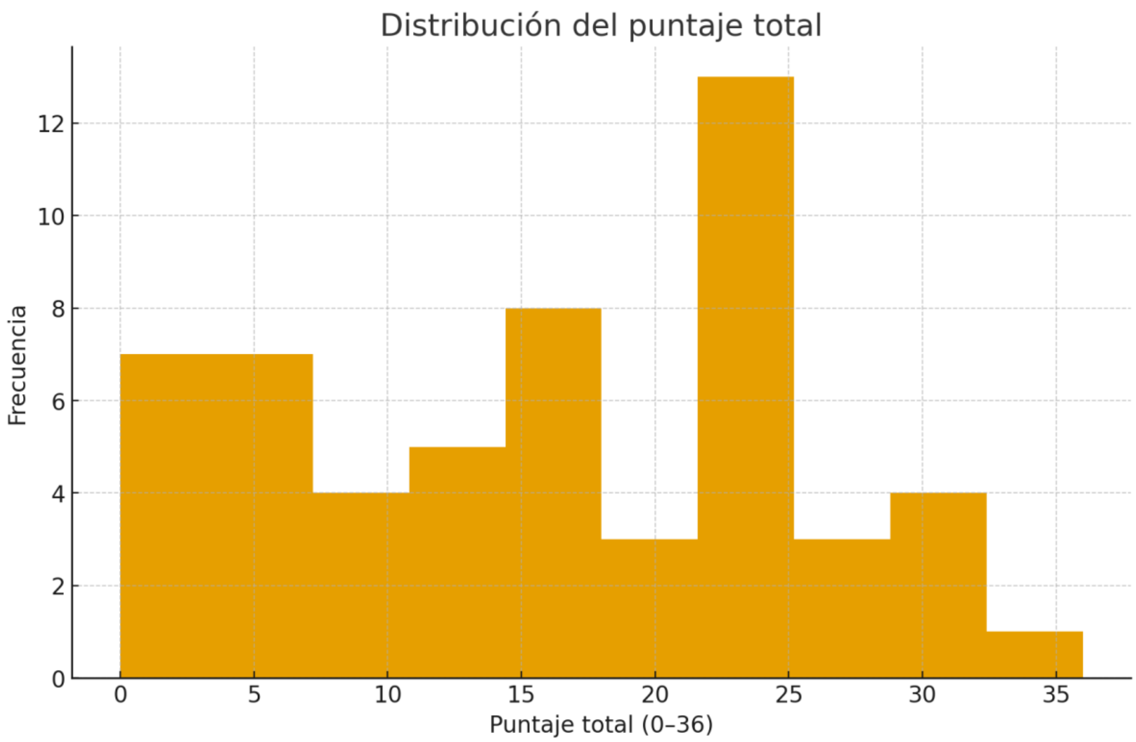

Table 2.

Distribution by item: frequencies and percentages (No/Sometimes/Yes)

Item	No (n)	No (%)	Sometimes (n)	Sometimes (%)	Without)	Yeah (%)	Total (n)
1 Do you feel frustrated by difficulties hearing during calls?	23	41.8	24	43.6	8	14.5	55
2. Do you feel anxious or tense about your hearing during days with a high call volume?	14	25.5	15	27.3	26	47.3	55
3. Do you avoid participating in conversations with colleagues because of difficulty hearing clearly?	39	72.2	11	20.4	4	7.4	54
4. Are you concerned that your hearing difficulties will affect your	18	32.7	4	7.3	33	60.0	55

Item	No (n)	No (%)	Sometimes (n)	Sometimes (%)	Without)	Yeah (%)	Total (n)
performance or quality metrics?							
5. Do you feel uncomfortable when you don't understand a customer and have to ask them to repeat themselves?	10	18.2	10	18.2	35	63.6	55
6. Do you feel tired or stressed at the end of the day from straining to hear?	23	41.8	16	29.1	16	29.1	55
7. Does your hearing make you feel insecure when interacting with supervisors or clients?	32	58.2	15	27.3	8	14.5	55
8. Do you feel embarrassed when you don't listen well in meetings or training sessions?	24	44.4	11	20.4	19	35.2	54
9. Does your hearing affect your mood (e.g., irritability) during work?	32	59.3	13	24.1	9	16.7	54
10 Are you worried that your hearing might worsen if you continue in this position?	21	38.9	8	14.8	25	46.3	54
11. Do you feel less efficient because you have to increase volume or ask for repetitions?	22	40.7	14	25.9	18	33.3	54
12. Do you experience emotional tension due to ringing or buzzing in your ears after a day's work?	27	49.1	17	30.9	11	20.0	55
13. Do you feel limited in applying for promotions or role changes	43	78.2	7	12.7	5	9.1	55

Item	No (n)	No (%)	Sometimes (n)	Sometimes (%)	Without)	Yeah (%)	Total (n)
because of your hearing?							
14. Do you have difficulty understanding the client when there is ambient noise in the apartment?	8	14.5	19	34.5	28	50.9	55
15. Do you have difficulty following meetings with several people talking?	27	49.1	12	21.8	16	29.1	55
16. Do you need to turn up the volume on your headset more than your colleagues?	24	43.6	18	32.7	13	23.6	55
17. Do you have trouble understanding customers with an accent or very low voice?	9	16.4	25	45.5	21	38.2	55
18. Do you have trouble understanding the customer when speaking over a speakerphone or using shared devices?	20	37.0	15	27.8	19	35.2	54

In this sample (n=55), more than four-fifths reported at least one affirmative item about hearing difficulty at work, and one in five reported ringing/whistling at the end of the workday. These findings are consistent with evidence that, even below classic thresholds for continuous noise damage, high-demand communication tasks in the presence of noise and with prolonged headphone use increase listening effort, fatigue, and discomfort (Hornsby, 2013; Basner et al., 2014). In particular, the highest proportions of "Yes" responses were concentrated in: the need to ask the client for repetitions, interference from ambient floor noise, anxiety during workdays with high call volume, and concern about performance and possible hearing impairment. This profile is consistent with a speech intelligibility deficit in noise rather than with overt hearing loss, a pattern described in noisy work contexts or with degraded signals (Cañete, 2023; Basner et al., 2014).

The observed performance concerns are consistent with meta-analyses and guidelines describing non-auditory effects of noise—stress, fatigue, and irritability—with implications for productivity and quality (Basner et al., 2014; WHO, 2018). Such reactions may exacerbate listening effort in telephone interactions where the signal lacks visual cues and SNR varies with accents, voice intensity, or background masking, all factors captured by our items (e.g., accent/quiet voice and floor noise).

The 20% with post-workday tinnitus is in the upper range of reported population prevalence (≈10–15% in adults) and suggests auditory vulnerability or exposure to transient peaks ("acoustic incidents") that, even without exceeding average limits, can precipitate annoyance and auditory reactivity in headset users (Bhatt et al., 2016; Basner et al., 2014). Although we did not measure tonal thresholds, basic and translational literature provides a plausible biological framework: noise-induced cochlear synaptopathy—loss of synapses between inner hair cells and auditory nerve fibers—can occur even after exposures that leave "normal" thresholds but impair temporal processing and speech understanding in noise (Kitama et al., 2025; Liberman & Kujawa, 2016). This model, together with the listening effort theory (Hornsby, 2013), helps to interpret why participants report discomfort, anxiety and fatigue without necessarily presenting with clinical hearing loss.

From an OSH management perspective, the observed pattern (need to increase the volume, request repetitions, and difficulties in meetings or with multiple interlocutors) suggests reviewing three fronts: (i) engineering (background noise control on the floor, quality of headbands with limiters and flat response, peak monitoring), (ii) work organization (listening breaks, task rotation, training in communication techniques to minimize repetitions), and (iii) health surveillance with audiological screening and research for tinnitus, hypersensitivity, or annoyance to sound (Basner et al., 2014; WHO, 2018). Primary prevention remains aligned with occupational noise exposure criteria, although evidence suggests that short peaks and high cognitive demands may underestimate the risk when assessed solely with averaged levels (Basner et al., 2014).

Our results should be read with caution. First, the measurement is self-reported and cross-sectional; we do not have audiometry, DPOAEs, or objective exposure measures (LAeq, SEL, peaks) that would allow for more robust causal attribution. Second, convenience sampling may limit generalizability. However, the instrument's internal consistency (α≈0.71) and convergence with conceptual domains reported in the literature—tinnitus, fatigue, anxiety, and intelligibility in noise—reinforce the construct's validity and its usefulness as a screening tool for prioritizing interventions.

In the future, longitudinal studies that integrate head-worn personal dosimeters, acoustic peak analysis, speech-in-noise tasks, and physiological markers (e.g., EHF >8 kHz, EFR, DPOAEs) could clarify the relationship between call load, background noise, and the progression of subclinical symptoms to hearing loss or persistent tinnitus (Liberman & Kujawa, 2016). In parallel, SNR improvement trials (room acoustics, voice-appropriate active cancellation, safe gain profiles), accompanied by scheduled breaks and auditory education, will allow for the quantification of benefits on repetitions, quality metrics, and well-being.

In summary, the high percentage of workers reporting discomfort due to not understanding the customer, noise interference, and concern about their hearing indicates the need for specific auditory control and monitoring actions for call center operations, in line with current evidence on auditory and non-auditory effects of noise and with pathophysiological models of subclinical synaptic damage related to chronic auditory demand.

Conclusion

The evidence obtained shows a significant perceptual burden of hearing difficulties in the daily work of call center agents, characterized by discomfort with not understanding the interlocutor, sustained listening efforts in noisy environments, concern about performance, and signals consistent with hearing discomfort at the end of the workday. This pattern aligns with conceptual frameworks that explain the degradation of speech intelligibility in noise and the increase in cognitive effort under continuous communication demands, even when clinical thresholds may appear to be maintained. The findings support the need for comprehensive interventions aimed at controlling the acoustic environment, optimizing communication devices, managing pauses, and providing auditory education. It is pertinent to incorporate health surveillance with periodic screening, specific research for ear discomfort, and early care pathways, articulated with improvements that prioritize signal clarity. The interpretation should consider the self-reported and cross-sectional nature of the data and the absence of objective exposure measurements. Despite these limitations, the instrument's internal consistency and consistency with the literature support the validity of the construct evaluated and its usefulness as an input for decision-making in occupational health and safety. It is recommended to move toward longitudinal designs that integrate personal dosimetry using headsets, standardized speech-in-noise tasks, and physiological markers, in order to accurately estimate the trajectory of hearing load and the effects of control measures on performance, well-being, and operational sustainability at work.

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